Wilderness Air Quality Value (WAQV) Class 2 Monitoring Plan
Gospel Hump Wilderness Area, Nez Perce National Forest
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May 15, 2007

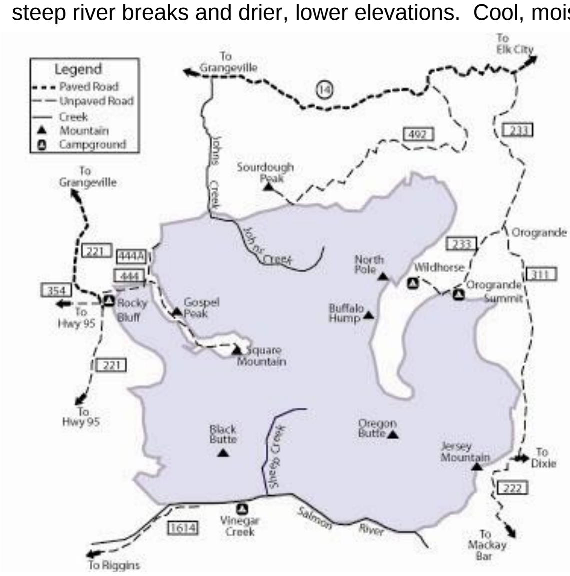
This WAQV plan was prepared to summarize the wilderness characteristics of the Gospel Hump Wilderness area on the Nez Perce National Forest, and explain the legal framework for air quality protection, identify wilderness air quality values, and provide a monitoring plan for Wilderness Air Quality Values (WAQVs). The Gospel Hump Wilderness (GHW) is Class 2 for the Clean Air Act PSD regulations. Air quality protection authority (beyond ambient air quality standards and Prevention of Significant Deterioration - PSD increments) for the GHW therefore relies primarily upon the Wilderness Act. This plan is designed to specify appropriate monitoring to protect the Class 2 WAQVs and to meet the Wilderness Stewardship Challenge to achieve the objectives of the Air Element #3
http://www.wilderness.net/index.cfm?fuse=toolboxes&sec=air

1) Location and Wilderness Characteristics

The Gospel Hump Wilderness comprises 206,053 acres of land entirely within the Nez Perce National Forest in Idaho County, Idaho. An east-west hydrographic divide separates the Wilderness into two distinct portions. The north portion drains into the South Fork of the Clearwater River. The south portion drains into the Salmon River.

The southern boundary of the GHW joins the Frank Church River of No Return Wilderness (FCRONRW) at the Salmon River. In North America, the Salmon River canyon is exceeded in depth only by Hells Canyon on the Snake River.

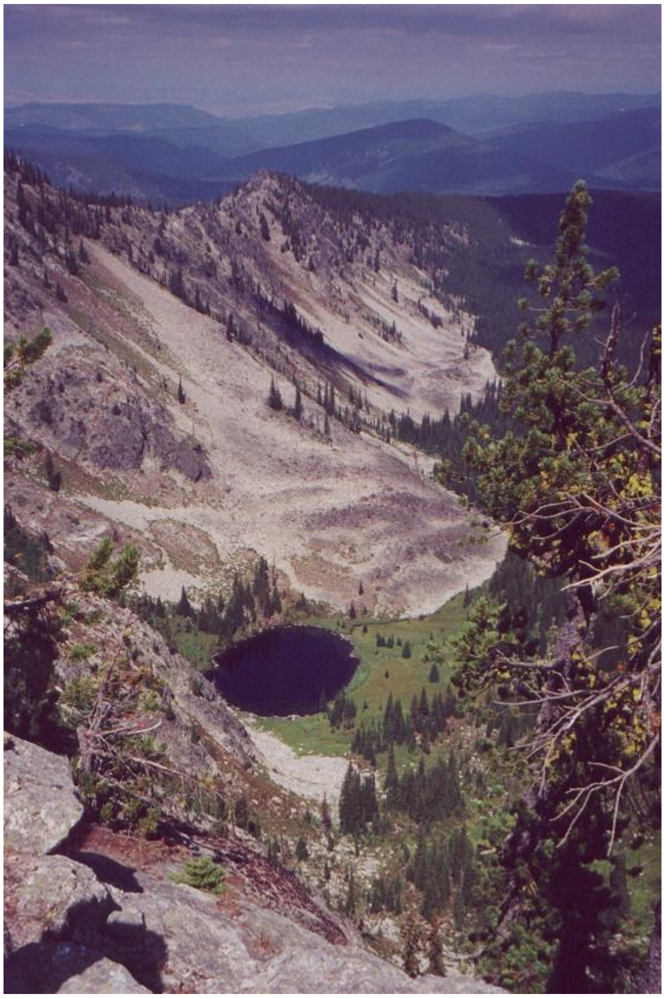
Elevations in the Wilderness range from 1970 feet at Wind River pack bridge on the Salmon River to 8940 feet at the summit of Buffalo Hump. Vegetative patterns reflect the differences in elevation and moisture. Ponderosa pine with cheat grass and shrub understory, dominate the steep river breaks and drier, lower elevations. Cool, moist lands at higher elevations are covered with Douglas fir, lodgepole pine, subalpine fire, and whitebark pine in association with beargrass and/or whortleberry.



Mean annual precipitation varies from 18 inches on the Salmon River to 60 inches at higher elevations. Winter snow depths range from light and discontinuous at the lower elevations, southerly aspects, to depths of 10-15 feet at higher elevations.

Because of past mining and grazing activities, the GHW has more

anthropogenic disturbance than most Wilderness areas in central Idaho.



The Endangered American Wilderness Act, P.L. 95-237, which created the Gospel Hump Wilderness area, was passed by the 95th Congress on February 24, 1978.

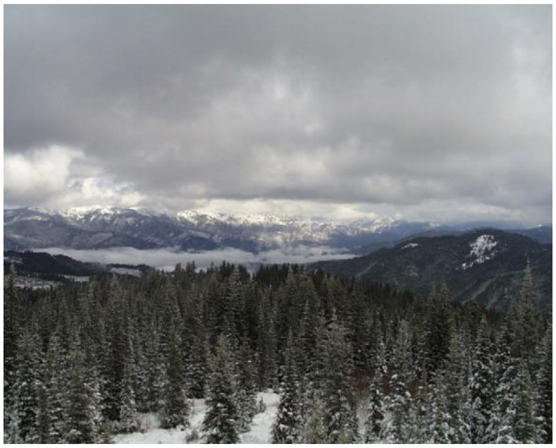
Recreation places a great demand on this Wilderness, with an estimated 29,000 recreation visitor days occurring in 1982. Very little visitor use occurs from November through June when the higher elevations are snowed in. Primary recreational activities are camping, horse riding and packing, hiking, fishing, and hunting. Most visitors are from Idaho. Much of the fall use is from hunters. Day hikers account for about half of the summer use, with about half camping (usually 1 night) in the Wilderness. These statistics change dramatically during fall hunting season when visitors camp for longer periods of time.

From July to early September use is concentrated at higher elevations and lake basins. From mid-September to November, use is scattered throughout the Wilderness, although it is heaviest near access points. Observation and experience indicate that the GHW is not being overused except around some focal points. Ease of access contributes to overuse in some areas. This is most apparent along the Square Mountain and Sawyer Ridge Roads.

The GHW has a long history of wildfire. Continually altered vegetative patterns have resulted in extensive mosaics of different species and age classes. The current pattern is made up of brush fields, large stands of lodgepole pine, and snag patches. Wildlife populations and distributions have responded to the changes in habitat created by these fires. The Gospel Hump Wilderness Fire Management Plan was approved for implementation in June 1984. This plan allows some fires, then called Prescribed Fires, to burn unsuppressed as long as they meet preplanned management objectives. Allowing these naturally ignited fires to burn will be

allowed to resume a more natural role in shaping Wilderness character, natural plant communities and wildlife habitat.

The Gospel Hump Wilderness has a number of unique and valuable characteristics. It is part of approximately 3,000,000 acres of essentially roadless area in central Idaho. The GHW contains rugged river break lands and high mountain lakes, offering opportunities for solitude, challenge, and primitive recreation. Mining and grazing have left remnants and study opportunities of a past culture. Anadromous fisheries and bighorn sheep populations are part of the areas unique wildlife resources. The Wilderness has been affected by man. These impacts include:



- Twenty miles of Hump Wagon Road.
- Two tracts of private land with associated buildings
- A bulldozer road and firelines from past fire suppression activities
- Two major “cherry stems” (non-wilderness “peninsulas”) that provide motorized use surrounded by Wilderness
- Two lookouts within the Wilderness that require maintenance

The Gospel Hump Wilderness Management Plan Specific (USFS, 1985) lists specific management objectives for the Gospel Hump Wilderness and resource specific guidance.

- To develop a public contact program to improve visitor orientation and cooperation.
- To establish guidelines for managing visitor use.
- To establish administrative uniformity throughout the area.
- To develop a fire management plan and prescriptions for the area.
- To permit the continuation of livestock grazing, while minimizing impacts to the Wilderness resource.
- To acquire needed rights-of-way across private in holdings.

Salmon River breaks on the south side of the Gospel Hump Wilderness. Photo courtesy of Google Earth, Europe Enterprises.

2) Policy and Direction

The Wilderness Act of 1964 contains language directing the management of wilderness to "…secure for the American people…and future generations the benefits of an enduring resource of wilderness …unimpaired for future use and enjoyment~~.~~" (Wilderness Act, PL 88-577, Sec. 2a) It further states that Congress intended to manage these wildernesses so that "…the earth and it's community of life are untrammeled by man…" and a wilderness must"…retain it's primeval character and influence…" and it"…appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable~~…"~~ " (Sec 2b). The direction provided in this act made it clear that Congress intended that the natural conditions in wilderness be preserved and that it be influenced primarily by the forces of nature rather than by human activity. The basic framework for controlling air pollutants in the United States is mandated by the Clean Air Act (CAA) of 1963, and amended in ~~1972~~1970, 1977, and 1990. The CAA was designed to "protect and enhance" air quality. Section 160 of the CAA requires measures "to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreation, scenic, or historic value." Stringent requirements are therefore established for areas designated as "Class I" areas. Class I areas include Forest Service and Fish and Wildlife Service wilderness areas over 5,000 acres that were in existence before August 1977 and National Parks in excess of 6,000 acres as of August 5, 1977. Designation as a Class I area allows only very small increments of new pollution above already existing air pollution levels. Class II areas include all other areas of the country that are not Class I. To date, there are no class III areas. The Gospel Hump Wilderness is a Class II areas since it was established after 8/5/77 (February 24, 1978).

The purpose of the CAA is to protect and enhance air quality while ensuring the protection of public health and welfare. The act established National Ambient Air Quality Standards (NAAQS), which must be met by state and federal agencies, and private industry. The EPA has established NAAQS for specific pollutants emitted in significant quantities that may be a danger to public health and welfare. These pollutants are called criteria pollutants and include carbon monoxide, nitrogen oxide, ozone, ~~and~~ sulfur dioxide, lead, and particulate matter (PM_{10} and ~~PM2.5~~$PM_{2.5}$). States are given primary responsibility for air quality management. Section 110 of the Clean Air Act requires States to develop State Implementation Plans (SIP) that identify how NAAQS compliance will be achieved. The NAAQS are designed to protect human health and public welfare. The CAA defines public welfare effects to include, but not be limited to, "effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility and

climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being~~.~~" (CAA Title 1, Part A, S. 109 http://www.epa.gov/air/criteria.html). If a community or area does not meet or "attain" the standards, it becomes a non-attainment area and must demonstrate to the public and EPA how it will meet standards in the future. This demonstration is done through the ~~State Implementation Plan (~~SIP process~~)~~.

Criteria pollutants such as sulfur dioxide and nitrogen dioxide are of concern because of their potential to cause adverse effects on plant life, water quality, aquatic species, and visibility. However, sources of these pollutants are generally associated with urbanization and industrialization rather than with natural resource management activities or wildfire. Wildfire and natural resource management activities such as timber harvest, road construction, site preparation, mining, and fire use can generate ozone, carbon monoxide, and particulate matter. While ozone is a by product of fire, potential ozone exposures are infrequent. The EPA is recommending a secondary ozone standard which will protect vegetation and animals http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_cr_sp.html. Carbon monoxide is rapidly diluted at short distances from a burning area, as fires are generally spatially and temporally dispersed, and pose little or no risk to public health.

The pollutant of most concern to public health and visibility in the Gospel Hump Wilderness is particulate matter. Even though particulate matter has no serious effects on ecosystems (fire and smoke are natural processes) it does affect human health and visibility. Because of its smaller size, $PM_{2.5}$ poses greater respiratory health system risks than $PM_{10.}$

The $PM_{2.5}$ standard requires concentrations of $PM_{2.5}$ not to exceed a 24-hr average of 35 ug/m^3 (micrograms per cubic meter). This standard was changed from the previous 65 ug/m3 by the EPA on 12~~9~~/~~2~~17/06 http://www.epa.gov/particles/fs20061006.html. Average annual arithmetic $PM_{2.5}$ concentrations are not to exceed 15 ug/m^3. Air quality State Implementation plan (SIP) for particulates is promulgated through the Idaho Environmental Health and Protection Act and implementing regulations, notably the Idaho DEQ ozone and $PM_{2.5}$ SIP of 12/16/06 http://deq.idaho.gov/air/data_reports/planning/interstate_transport_sip.pdf. The regulations provide specific guidance on maintenance of air quality, including restrictions on open burning (ARM 16.8.1300). The act created the Idaho DEQ Air Quality Division and the regulatory authority to implement and enforce the codified regulations.

3) Pollution Sources and Air Quality Conditions

The GHW air quality is generally good with limited upwind large stationary local emission sources and periodic robust wind dispersion. The GHA is subject to long distance transport emissions from sources to the west in Oregon and Washington. Existing sources of emissions in the GHW includes dust from trails during dry conditions and smoke emissions from wildfires, wildland fire use, and prescribed burns. Adjacent area sources are primarily occasional construction equipment, vehicles, road dust, residential wood burning, wood fires, and smoke from logging emissions slash disposal, prescribed burns, and wildfires. The GHW receives some vehicle, residential, and construction emissions from the from Grangeville to McCall corridor along Highway 95, adjacent logging, jet boat emissions on the Salmon river, and snowmobile emissions along the Buffalo Hump corridor. Local emission levels area low due to the sparsely population area and vast areas for dispersion. Down valley airflow in the GHW drainages (Johns Creek and Crooked Creek on the north and Salmon River tributaries on the south – Wind River, Sheep Creek, and Crooked Creek) is frequently robust during nighttime and early morning hours. The entire GHW is considered to be in attainment by the Idaho DEQ.

Idaho's non- attainment areas include
http://deq.idaho.gov/air/data_reports/monitoring/overview.cfm#Idaho

Area	Description	Pollutant	Background
Sandpoint	Located in Bonner County, the area rests on the northwest corner of Lake Pend Oreille within the Panhandle National Forest.	PM_{10}	The topography influences much of the PM buildup in the area. In 1997, the area was designated moderate PM10 non-attainment, and an emissions inventory identified the primary PM10 source as residential wood burning. Fugitive road dust and some industrial sources are also considered significant contributors.
Pinehurst	Located in Shoshone County and rests in the Silver Valley surrounded by the Coeur d'Alene and St. Joe National Forests.	PM_{10}	The area's topography is a significant factor in the buildup of pollutants that result in poor air quality. The emission inventory identified residential wood burning as the primary PM10 source and fugitive road dust as a secondary source.
Portneuf Valley	96.6 square miles of Pocatello, Chubbuck, and surrounding areas	PM_{10}	Formerly the Power/Bannock County PM10 area; split into Portneuf Valley and federal Fort Hall PM10 areas. Includes federal land managed by the Bureau of Land Management and the Caribou National Forest, as well as privately owned land in the cities of Pocatello and Chubbuck.
Northern Ada County	Southwestern Idaho	Carbon Monoxide (CO)	At present, Northern Ada County is a Limited Maintenance Area. Northern Ada County is Idaho's only designated CO Maintenance Area. Mobile and area source emissions are the two major sources of CO.

Some emissions from the Pinehurst non-attainment area (PM_{10}) and industrial emissions from Ada County (Boise) have potential to be periodically transported to the GHW.

The EPA AIRS data base http://www.epa.gov/air/data/netemis.html lists 3 wood product industry sources of emissions in the counties surrounding the GHW. The AIRS database includes 1999 emission levels in the GHW area which combine for about 6.5 tons/year of NOx,

121 tons/year of $PM_{10,}$ and 2.55 tons/year of SO_2. East of the Gospel Hump Wilderness the prevailing wind direction is through the Frank Church River of No Return and Selway Bitterroot Wilderness areas which greatly limits industrial or residential air pollution sources.

Gospel Hump Wilderness general area stationary emission sources

Pollutant Emissions										
CO	**NH3**	**NOx**	**PM10**	**PM2.5**	**SO2**	**VOC**	**Facility Name**	**Location**	**County**	**Industry Type**
807		275	24.1	21.8	8.88	17.8	Potlatch Corporation Wood Products Division	Pierce	Clearwater	Softwood Veneer And Plywood
246		110	59.2	41.1	10.5	23.8	Evergreen Forests & Tamarack Energy Partnership	New Meadows	Adams	Sawmills & Planing Mills General
96.7		6.46	121	84.3	2.55	56.5	Shearer Lumber Products	Elk City	Idaho	Sawmills & Planing Mills General
1,150		392	204	147	21.9	98.1				

The GHA is located east of several large stationary sources of industrial emissions in Oregon and Washington. The map below is from Ferguson and Rorig (2003) http://www.fs.fed.us/pnw/pubs/gtr590.pdf which plots the numerous point emission sources in western Oregon.

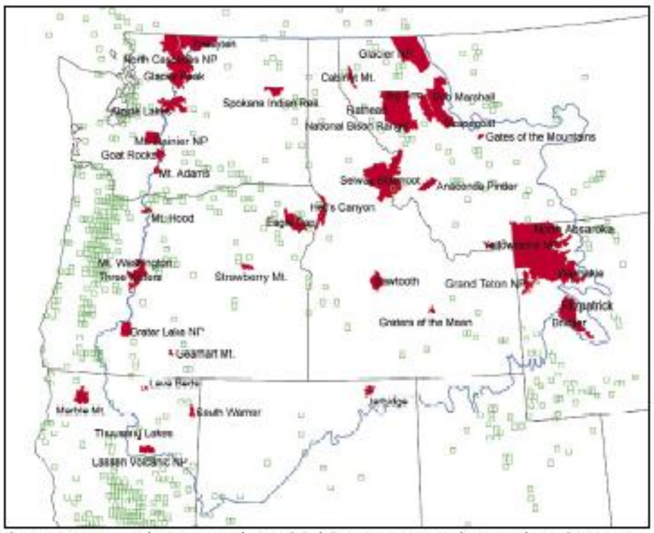


Figure 1—The Northwestern United States. The Interior Columbia Basin Ecosystem Management Project boundary is shown in blue, class I wilderness areas are red, and open green squares show point-source emission locations.

Ferguson and Rorig (2003) plot pollution potential for point sources based on emission amounts and prevailing wind direction at 3 heights (surface, 700mb, and 850mb) for January, April, July, and October. Generally surface trajectories remain localized but the higher elevation 700mb, and 850mb trajectories can be moved eastward by upper level winds. The Ferguson and Rorig (2003) maps show Washington large source (Puget Sound area) and the lower Willamette valley Oregon source trajectories Portland generally to the north of the GHW. The map below is for October at 850 mb for particulate matter, nitrogen oxides, sulfur oxides, and ammonia which shows most of the largest source trajectories remaining north of the GHW.

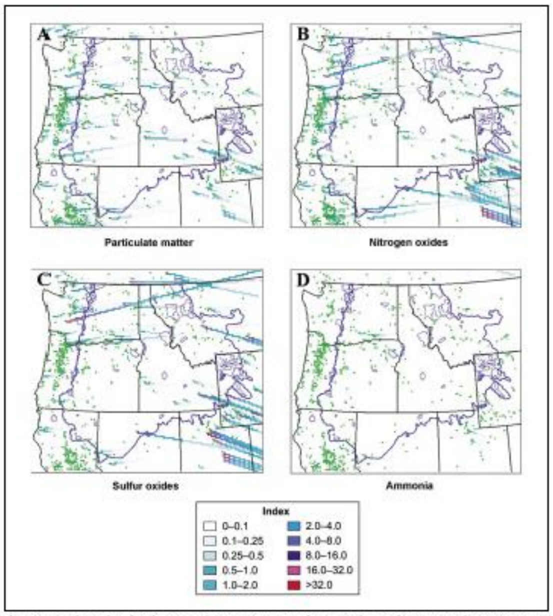


Figure 12—Potential pollution trajectories at 700 mb in October for (A) total particulates, (B) nitrogen oxides, (C) sulfur oxides, and (D) ammonia. Colors indicate the value of an index, which is based on the value of emission concentrations at the source divided by wind speed and distance from the source. Class I areas are outlined, and green squares show point source emission locations.

Ferguson (1998) plots 30 average monthly – mean surface winds for the Pacific Northwest http://www.fs.fed.us/pnw/pubs/gtr434.pdf January surface winds in Oregon and Washington have a predominantly north trajectory. July winds, which have less velocity, generally have a W to SW orientation. The map below is for January surface winds. The Ferguson (1998) wind maps also indicate that most of the station emission sources in Oregon and Washington would be transported north of the GHW.

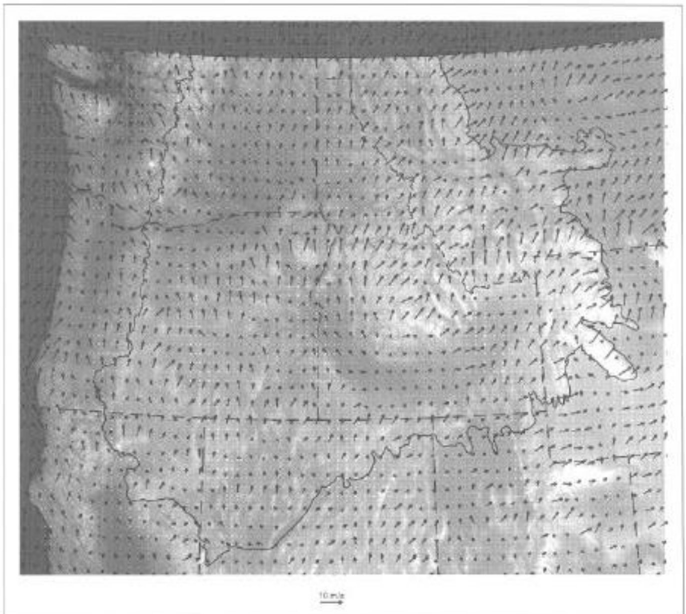


Figure 16—The 30-year average of monthly-mean surface winds in January.

Regional wildfire smoke has accumulated in much of Idaho and western Montana during periods of extensive wildfire activity in 1988, 1994, 2000, 2003, and 2006. The prime source of wildfire emissions is from central and northern Idaho, and western Montana. The episodic wildfire events are by far the most impactive factor affecting air quality and visibility in the GHW.

The nearest Class I area to the GHW is the Hells Canyon Wilderness which is 24 miles to the South.

Lake Chemistry

The Gospel Hump Wilderness has about 86 lakes. Chemical records can indicate changes in a lake's composition, which in sensitive lakes is indicative of atmospheric chemistry. Imbalance of lake chemistry toward either acidic or basic conditions can affect microorganisms, and invertebrates, ultimately affecting the health and productivity of fish.

The Gospel Hump Wilderness parent material is predominantly Precambrian meta-sedimentary rock and Mesozoic granitic intrusives (Idaho Batholith). USFS (1978) indicates that the Hump area is a large anticlinal structure with igneous intrusives into the Precambrian parent material. The mineralized veins occupy a crestal position and are genetically related to the intrusive rocks consisting of granite, schist and quartzites USFS (1978). The lake chemistry, discussed below has sharp alkalinity stratification around timberline in the GHW. For example, the Gospel and Knox lakes have alkalinities <50ueq/L where lakes in the same quartzite or quart mozonite-granodiorite formations but at lower elevation have alkalinities in the 75 to 150ueq/L range.

The difference is likely due to more developed coniferous vegetation, deeper soils, and more accelerated weathering rates in the lower elevation watersheds which generates more alkalinity in the lakes (and hence more pH buffering capacity).

The lake chemistry of West Kelly Lake in the GHW was monitored on September 21, 1985 in the EPA (1985) Western Lake Survey at (Landers, et.al, 1987). The chemistry data from this sampling event is shown in the table below.

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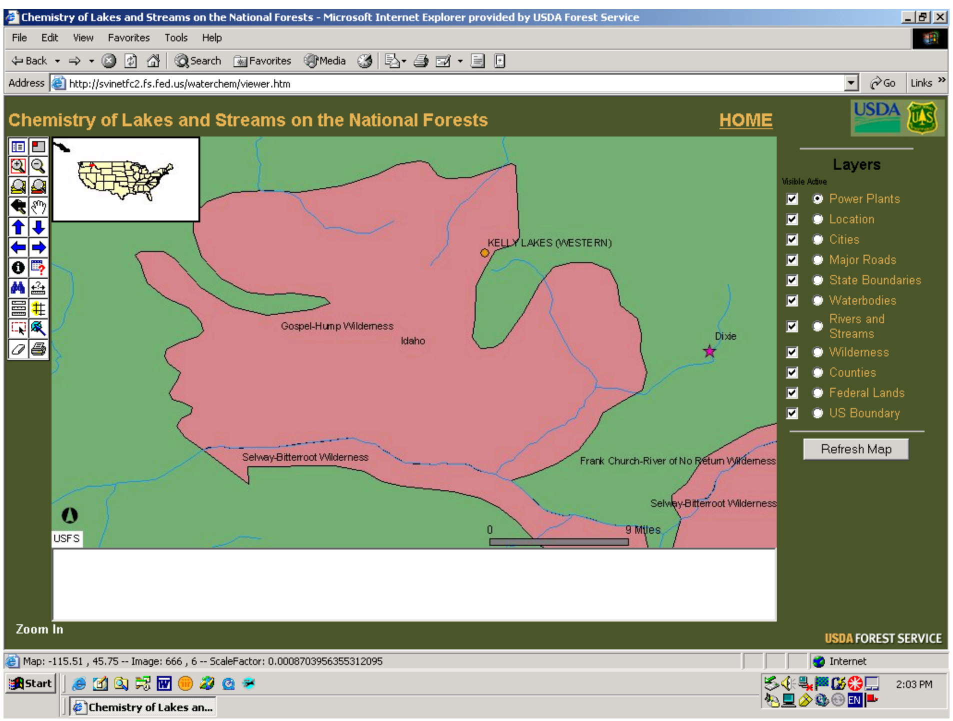
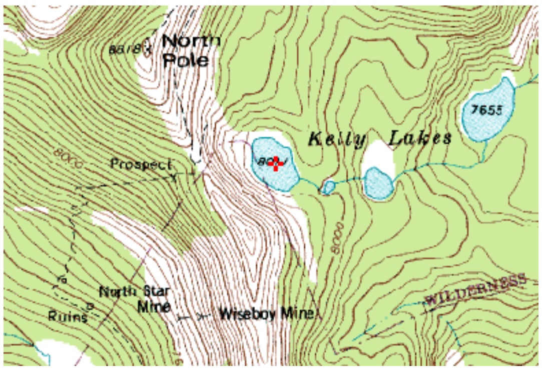
				ANC	HCO3	Ca	Mg	Na	K
Lake	Location	Lake ID	pH	ueq/l	ueq/l	ueq/l	ueq/l	ueq/l	ueq/l
West Kelly Lake	28N 15W S4	4C2-019	6.99	77.9	56.4	33.5	7.6	26.4	3.2
			NH4	SO4	Cl	NO3	F	Cond.	
	Location	Lake ID	ueq/l	ueq/l	ueq/l	ueq/l	ueq/l	uS/cm	
	28N 15W S4	4C2-019	0	5.5	1.7	0.2	1.0	6.3	



The West Kelly lake sampling location is shown on the map below from the USFS Air lake data website at http://svinetfc2.fs.fed.us/waterchem/viewer.htm



West Kelly Lake 4C2-019 which was sampled as part of the EPA Western Lakes survey on 9/21/85. This is the same lake as Kelly #4 below sampled in the Nez Perce High Lake Fisheries project in 1989. Data for both sampling events is very similar.

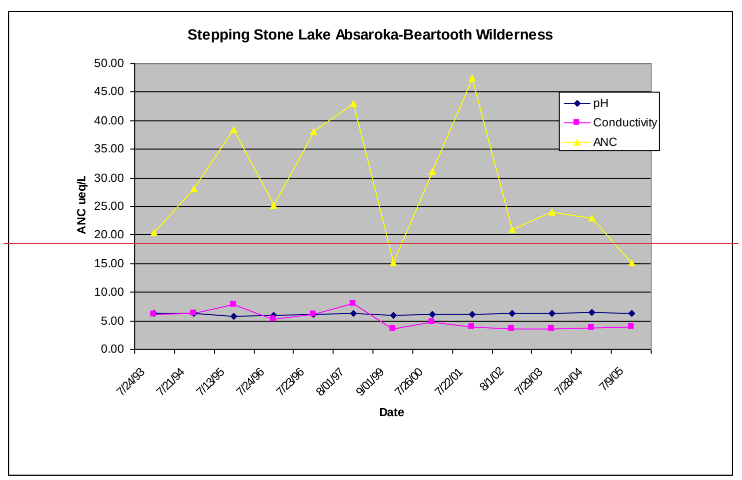
Upper Gospel Lake, September 2003, photo courtesy of Steve Armstrong, Nez Perce NF.

The Nez Perce NF and Idaho Department of Fish and Game sampled 46 lakes the GHW on July, August, and September of 1989 (Bahls, 1990). The sampling was part of the Nez Perce High Lake Fisheries Project. The project included an extensive inventory of lake mapping and bathometry, bottom substrate composition (littoral zone), water chemistry, inlet and outlet stream geometry, lake basin vegetation, fish stocking records, gill net of fish type/size/number, campsites, and access. Protocols are documented in Bahls (1989). Water chemistry in the table below is from the shallow literal zone with is comparable to grab sample techniques in other USFS R1 synoptic chemistry and WAQV plan reports. Alkalinity was measured using the gran titration technique Bahls (1989).

Lake	Sample Date	Location	pH	Alkalinity ueq/l	Conductivity umhos/cm
Bear	7/1/89	26N 6E S13	6.78	87	9.2
Brandon, Lower	8/16/89	25N 6E S9	6.98	101.8	11.9
Crescent	6/30/89	26N 6E S13	6.33	39.2	4.8
Crystal	9/9/88	34N 10E S34			5.2
Crystal	8/9/89	27N 6E S35	7.42	159.8	16.9
Deer	8/10/89	26N 6E S35	7.12	127.2	15.7
Emerald	7/29/89	26N 4E S36	7.07	68.1	7.6
Fawn	8/12/89	25N 7E S6	6.74	60.7	12
Fish	6/28/89	26N 7E S8	7.17	138.1	14.6
Gospel, East	7/12/89	27N 4E S35	6.82	49.6	7.8
Gospel, Lower	7/13/89	27N 4E S35	6.71	46.6	6.8
Gospel, Upper	7/14/89	27N 4E S34	6.62	46.8	5.8
Half Acre	8/15/89	26N 6E S28	7.72		62.9
Hidden	7/31/89	26N 5E S14	6.95	56.6	7.8
Hump	7/4/89	26N 6E S2	6.75	148	16
Hurst	8/17/89	25N 6E S16	6.96	90	11.3
Indigo	7/28/89	26N 4E S35	7.59	253.8	25.5
Kelly #1	8/5/89	27N 6E S25	7.17	61.9	6.7
Kelly #2	8/6/89	27N 6E S26	7.27	77.2	6.8
Kelly #3	8/8/89	27N 6E S26	6.92	61.3	6.9
Kelly #4	8/7/89	27N 6E S26	7.14	64.1	6.9
Knob, Lower	7/17/89	27N 4E S36	6.57	77.6	8.5
Knob, Middle	7/18/89	27N 4E S36	6.06	66.6	5.8
Knob, Upper	7/15/89	27N 4E S1	6.34	25.8	3.6
Knob, West	7/16/89	26N 4E S2	6.79	38	4.9
Lake Creek	7/5/89	26N 7E S6	6.42	90.9	8.5
Lost	6/20/89	28N 6E S32	6.9	76.5	6.2
Mirror	8/13/89	26N 6E S3	8.39	308.7	33.5
Moores	7/19/89	26N 5E S6	7	158.5	20.5
Oregon Butte	8/13/89	25N 6E S12	7.08	49	7.2
Quartz	8/18/89	25N 6E S8	7.1	93.2	13.1
Rainbow, Lower	9/4/89	27N 7E S20	7	116	11.6
Rainbow, Upper	9/4/89	27N 7E S19	7.04	68.2	8.5
Round	8/11/89	26N 6E S35	7.27	112	14.2
Ruby	7/3/89	26N 6E S24	6.57	56.3	6.4
Shining	8/14/89	26N 6E S28	7.96	470	50.1
Slate, Lower	7/27/89	26N 4E S10	6.96	113.4	13.5
Slate, Upper	7/26/89	26N 4E S15	6.86	46.4	5.6
Square Mountain	7/30/89	26N 5E S8	7.59	201.4	19.3
Twin, Lower	7/31/89	27N 5E S34	6.96	101.1	10.9
Twin, Upper	8/2/89	26N 5E S3	6.82	82	9
Twenty Mile	6/18/89	27N 6E S5	6.67	82	13.5
Wildhorse	7/6/89	27N 7E S30	6.85	64.1	7.1
Wiseboy, Lower	8/11/89	27N 6E S34	7.46	98	12
Wiseboy, Mine	8/8/89	27N 6E S35	6.91	159.5	17
Wiseboy, Upper	8/11/89	27N 6E S34	7.32	91.9	10.4
Average			7.0	104.6	12.8

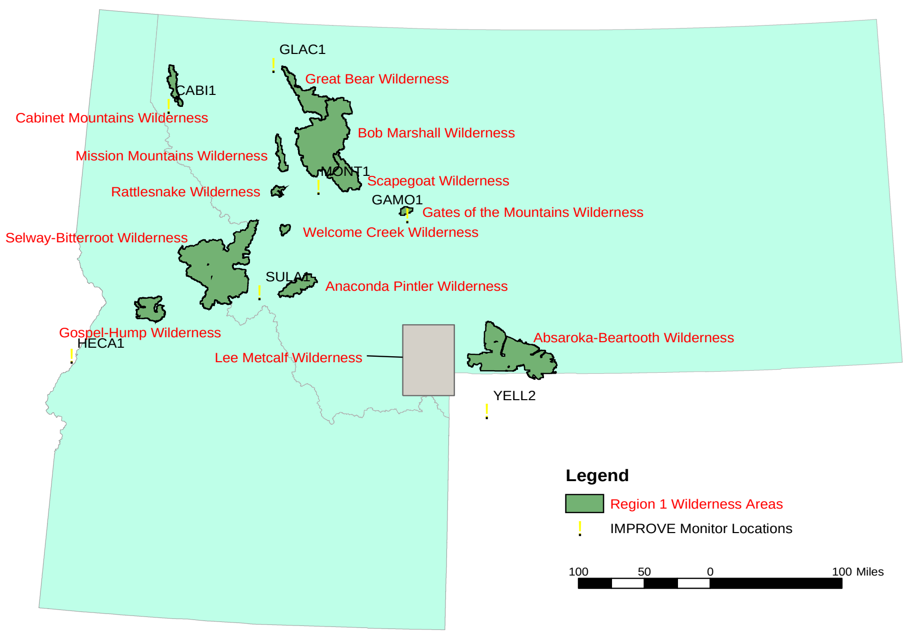
Average pH of the lakes sampled was 7.0. Alkalinity averaged 106.6 ueq/L and conductivity 12.8 umhos/cm. Alkalinity ranged from 25.8 ueq/L at upper Knob Lake to 308.7 ueq/L at Mirror Lake.

The 86 GHW lakes are located in Precambrian meta-sedimentary rock and Mesozoic granitic intrusives (Idaho Batholith). Granitic bedrock weathering typically is associated with water of low dissolved solids with limited buffering capacity and can be susceptible to acidification from air deposition of acid precursors. A key indicator of buffering capacity and therefore pH and chemical/biological stability in a lake is acid neutralizing capacity (ANC), which is similar to bicarbonate alkalinity in most lake systems (including the GHW) and is the sum of the base cations minus acid anions. The Western Lake Survey data for West Kelly lake, with the dominance of calcium carbonate in both cations and anions, confirm that this and most of the GHW lakes are likely calcium carbonate dominated systems. Lakes are generally considered sensitive to atmospheric induced acid deposition change if ANC is less than 50 ueq/L and highly sensitive if ANC is less than 25 ueq/L. A total of 8 lakes in the GHW have alkalinities of less than 50 ueq/L including Crescent, Upper Gospel, East Gospel, Lower Gospel, Upper Knob, West Knob, Oregon Butte, and Square Mountain and are sensitive lakes to acid deposition. It would be useful in subsequent sampling to include a more complete suite of chemical parameters to diagnose acid neutralizing capacity (ANC or sum of base cations – sum of acid anions) and to assess the concentrations of dissolved sulfate (likely of geologic origin) and dissolved nitrate (likely of atmospheric source). Gurrieri (2007), in a evaluation of 87 lakes on the Salmon-Challis National Forest (sampled in 1985 (WLS) 1994 and 1998, found that 56 of the 87 lakes are considered sensitive to acid deposition as defined by an acid neutralizing capacity (ANC) of less than 100 μeq/l. Some lakes show the presence of nitrate (NO_3) during the growing season which is a possible indication of nitrification. Guerri (2007) concluded that 2 areas of the Frank Church River of No Return Wilderness show geochemical and physical conditions favorable for establishing long-term monitoring lakes, Bighorn Crags and the Crimson Lake area north of Cabin Creek Peak. It would be useful to coordinate future lake monitoring of the GHW lakes to similar efforts in the Frank Church RONR Wilderness (field protocols, use same lab with the same parameters, same summer sampling period etc.).



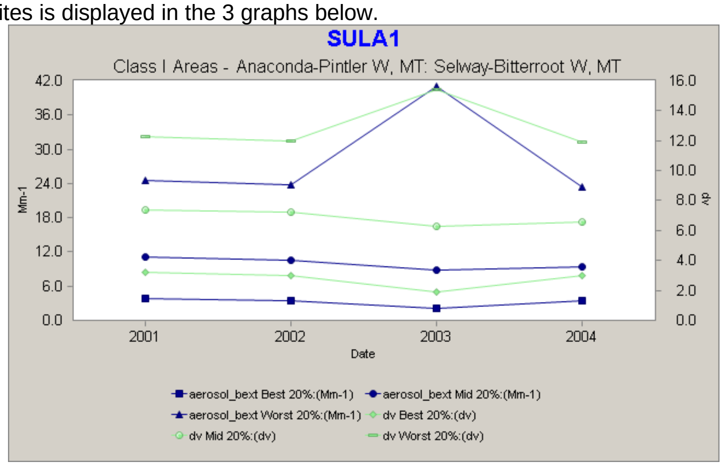
Visibility

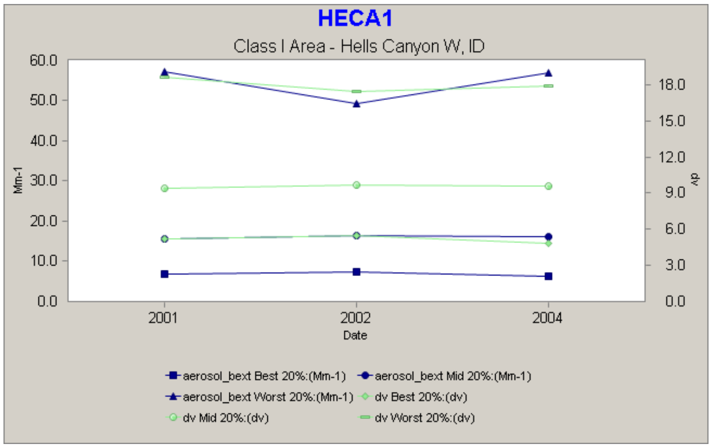
A key air quality value in any wilderness area is visibility. Visibility in the GHW is generally good due to absence of large stationary sources, generally dry air, and adequate wind dispersion. Smoke from wildfires and periodic prescribed burning and regional agricultural burning is the main source of GHW visibility reductions. ~~The~~ The Interagency Monitoring of Protected Visual Environments (IMPROVE) program (~~, however,~~ http://vista.cira.colostate.edu/improve/) is a national network to assess visibility in Class 1 areas. The Gospel Hump Wilderness is bracketed by 3 IMPROVE sites including Hells Canyon (HECA1), Sula Peak (SULA1) for the Selway Bitterroot Wilderness, and Sawtooth Wilderness (SAWT1). The Sula Peak Site is about 129 miles east of the GHW, Hells Canyon site about 27 miles south, and the Sawtooth Wilderness site about 135 miles south. The Sula Peak and Sawtooth IMPROVE sites have been in operation since 1994. The Hells Canyon site started in 2001.

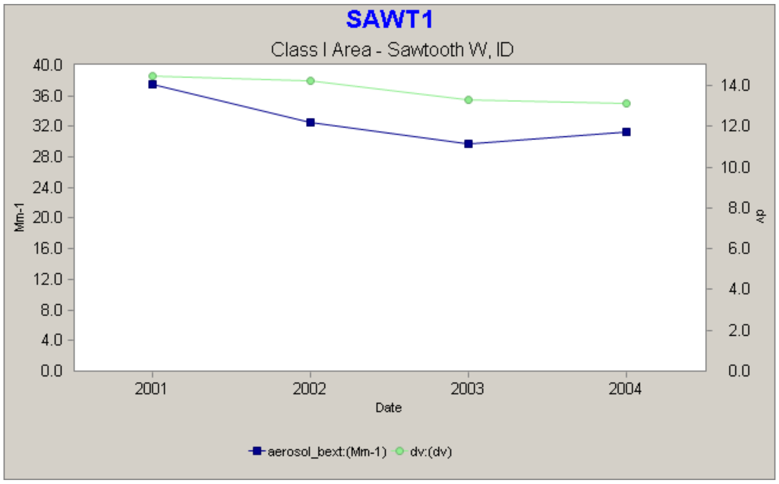


Trend data is available at http://vista.cira.colostate.edu/dev/web/AnnualSummaryDev/trends.aspx which shows visibility trends since the IMPROVE particulate monitoring equipment was installed. The graphs below show trends in light extinction and deciviews which are indices of visibility. Air quality State Implementation Plan (SIP) for particulates is promulgated through the Idaho Environmental Health and Protection Act and implementing regulations. The deciview unit is a haze index which is a measure of visibility derived from calculated light extinction measurements so that uniform changes in the haze index correspond to uniform incremental changes in visual perception across the entire range of conditions from pristine to highly

impaired. The haze index [in units of deciviews (dv)] is calculated directly from the total light extinction [bext expressed in inverse megameters (Mm-1)] as follows: HI = 10 in (b_{ext}/10). The Hells Canyon IMPROVE site shows generally stable to improving visibility trends for the best and middle days from 2001 to 2004 but much higher deciviews and extinction (reduced visibility) during the robust wildfire year in 2003. The Hells Canyon IMPROVE site had a fairly stable trend from 2001 to 2004 while the Sawtooth IMPROVE site has an increasing visibility trend during the period indicating that the highest concentration of wildfire smoke in 2003 (northern Bitterroot and Flathead watersheds) was north and east of the SAWT1 site. Trend data from the 3 improve sites is displayed in the 3 graphs below.

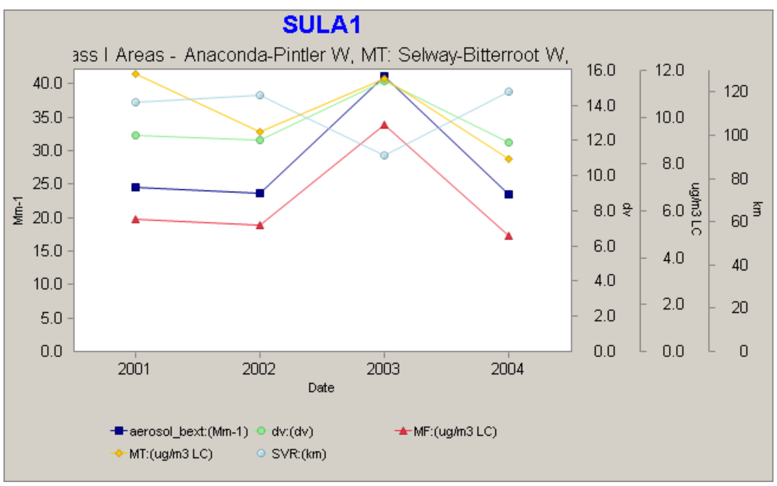


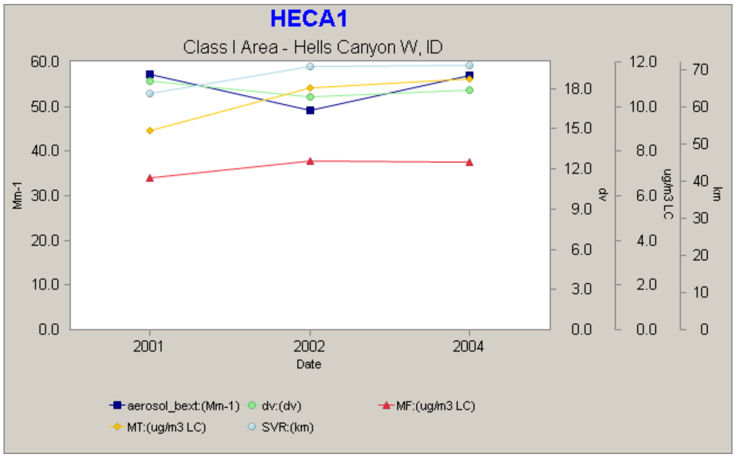




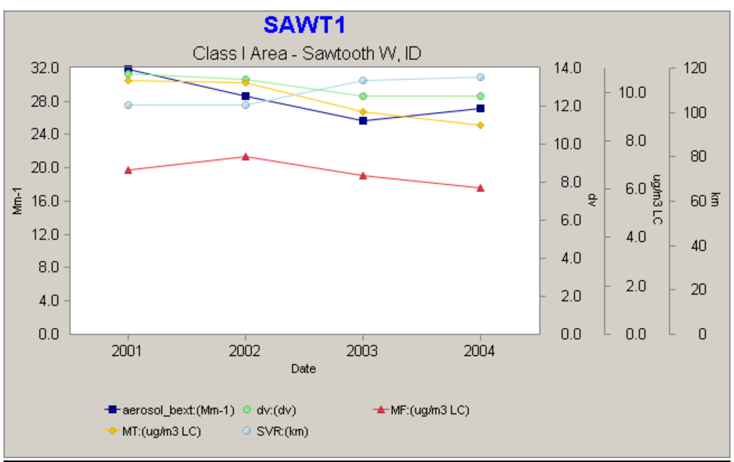
The IMPROVE data was also converted for SVR (standard visual range in kilometers) and deciviews which shows the inverse correlation between SVR and deciviews. For the Sula Peak IMPROVE sites visibility is closely cor~~e~~related to wildfire activity while for the Hells Canyon and Sawtooth IMPROVE sites the correlation with wildfires is not as distinct.

~~which is the same for the North Absaroka Wilderness which had lower SVR due to the 2003 wildfire season.~~





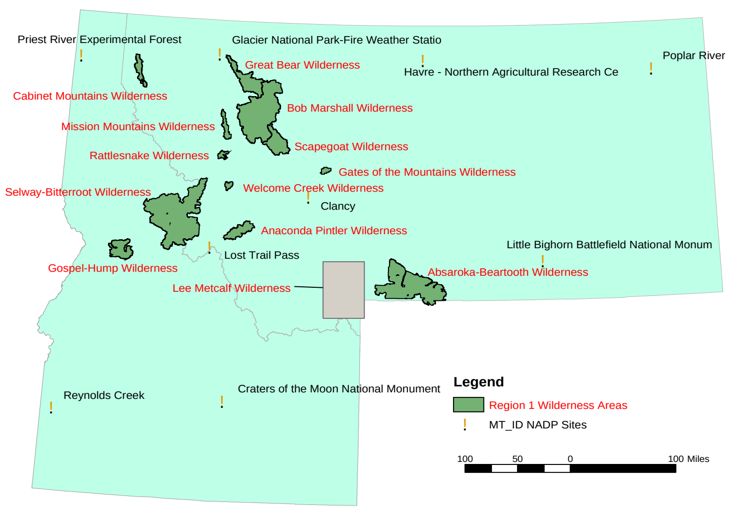
For the SULA1, HECA1, and SAWT1 sites the mass IMPROVE data demonstrates the correlation between particulates and light extinction (aerosol bext) and visibility (dv and SVR). The MF is fine mass ($PM_{2.5}$ or particles < 2.5 um diameter). MT is total mass (PM_{10} or particles < 10 um diameter). MT – MF = CM or coarse mass which is a component of aerosol reconstructed extinction. The recorded MT was highest at Hells Canyon in 2004. The Sawtooth IMPROVE site had generally less fine and coarse mass and higher visibility from 2002 to 2004.

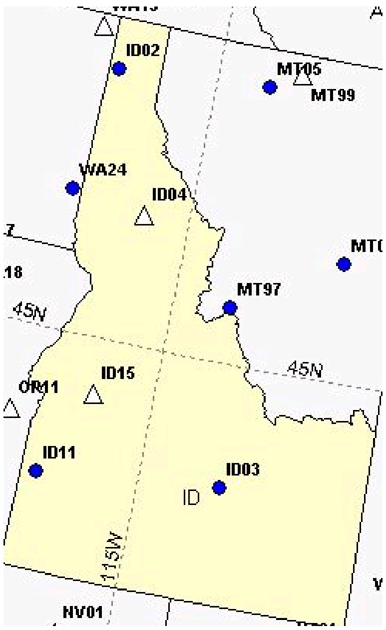


The SULA1, HECA1, and SAWT1 IMPROVE sites bracket the Gospel Hump Wilderness with only very minor emission sources between these sites and the GHW. The HECA1 site, however, is at much lower elevation than the GHW and is only representative of regional, not local sources. The

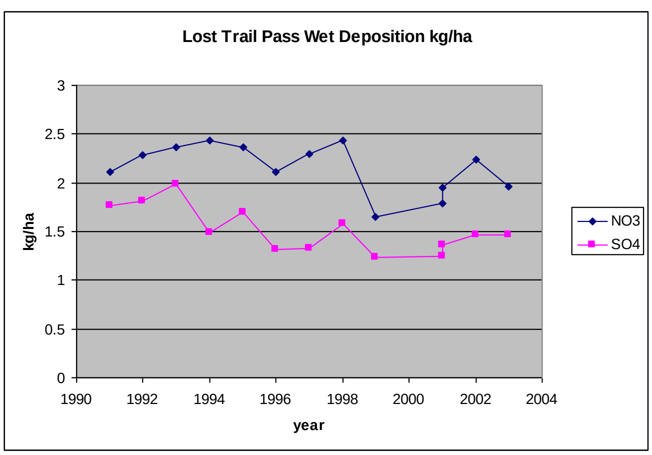
IMPROVE sites, however are reasonabl~~y~~e approximations of visibility conditions in west central Idaho, including the HCW.

National Atmospheric (NADP) Sites





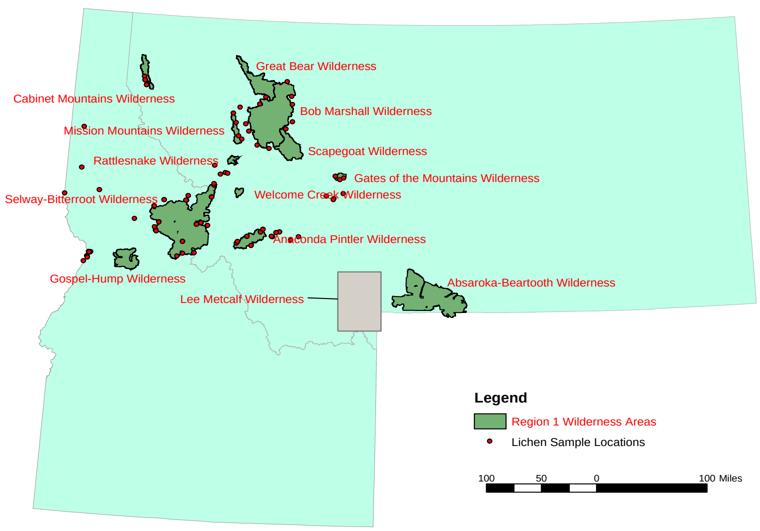
The GHW is bracketed by 4 NADP (National Atmospheric Deposition Program) sites in Idaho, Washington, and Western Montana including the ID02 site at Priest Lake (operated by the USDA-ARS and USGS), WA24 site at Palouse Conservation Farm (operated by the USDA-ARS USGS), the Lost Trail Pass MT97 site (operated by the Bitterroot NF), and the ID03 site (operated by the NPS). The ID02 site was started in 2002, Palouse Conservation Farm site in 1985, MT97 in 1990, and ID03 in 1983. The NADP Program was initiated in 1978 to monitor geographical and temporal trends in the chemical composition of rain and snow (wet deposition) with the primary purpose of acid rain benchmark monitoring. The program was prompted by scientific evidence and public concern in the 1970's that acid rain could be damaging aquatic ecosystems throughout the United States. The program grew steadily though the early 1980's and has stabilized at about 200 sites. The NADP network is used by a wide variety of government administrators and university scientists in monitoring the amounts of atmospheric deposition and effects on agriculture, forests, rangelands, freshwater streams, lakes, and cultural resources. Atmospheric deposition is commonly referred as "acid rain" but can occur as acid snow, fog, or dry deposition. The NADP data from all sites is readily retrievable at the NADP web site at http://nadp.sws.uiuc.edu.



The MT97 Lost Trail Pass NADP site, although downwind of the GHW, is the closest and most diagnostic site to GHW acid deposition levels since it is a similar elevation to much of the GHW with virtually no permanent emission sources between the GHW and MT97. It should be noted, however, that the GHW is closer than MT97 to the point sources in Oregon and Washington and would be expected to have slightly greater amounts of nitrate and sulfate deposition. An important parameter in trend analysis and acid deposition ecological significance is total wet deposition of sulfate and nitrate in kilograms/hectare (kg/ha) shown in the graph above. A major variable in total wet deposition is precipitation so that wet deposition is greater in high precipitation years. In general, sulfate deposition slightly decreased through 2003 with a slight increase from 1999 to 2004. Annual nitrate deposition plots similarly. The slight increase in sulfate and nitrate deposition from 2000 through 2004 may be due primarily to increased precipitation after 2000. The overall lack of increase in nitrate deposition at MT97 is not consistent with overall trends for mobile source (vehicle) emissions in the Western US, which are increasing for NOx emissions (Lynch, 1996, Peterson and Sullivan, 1998). In general NOx emissions are increasing in the Western US due to mobile sources (mainly vehicles) as the population grows as well as increasing small industrial facilities (Peterson and Sullivan, 1998). .

The slight decrease in overall sulfate deposition is consistent with overall Western US trends as industrial SO_2 sources have decreased. Many of the historic largest Western US SO_2 sources have shut down or are improving air pollution control technology.

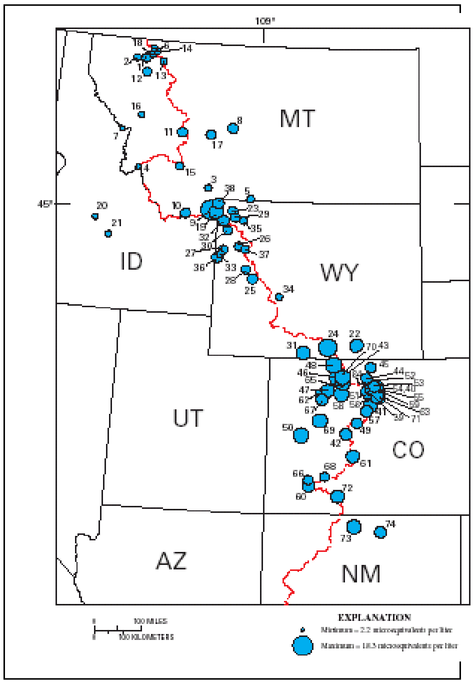
Lichens

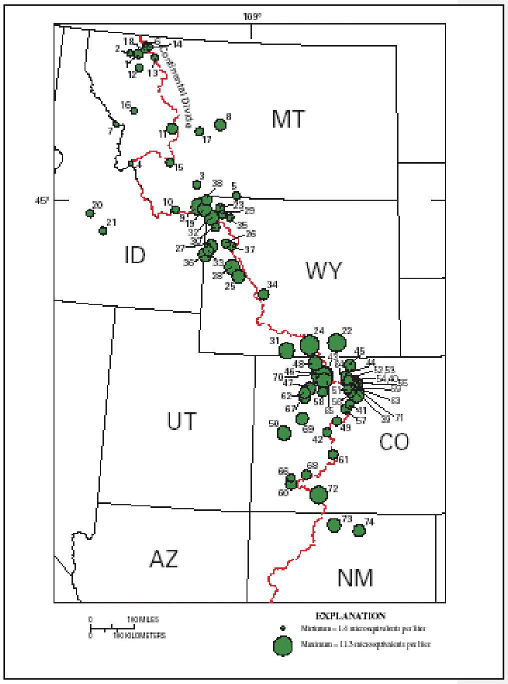


Lichens can be useful biologic indicators of air quality since many lichen species are very sensitive to air pollutants and accumulate air contaminants in lichen thallus tissue.
Dr. Larry St. Clair, BYU, had been collecting lichen samples in USFS Class 1 areas since 1992 including samples in the Anaconda-Pitler, Selway Bitterroot, Cabinet Mountains, and Bob Marshall Wilderness (St. Clair, 2005). Sixteen sites on the periphery of the Selway Bitterroot Wilderness (SBW) were established in 1992, 1993, and 1994 and re-sampled in 2000, 2001, and 2002 for lichen amounts, lichen species and community composition, and elemental analysis of the lichen thallus tissue. Elemental chemical analysis of 45 Selway Bitterroot Wilderness sites was done for all samples. For the Selway Bitterroot Wilderness sites, St. Clair found (2005) that some decreases and some increases in chemical concentrations between 1992 and 2000 to 2002. Four sites (all high elevation) showed moderately elevated sulfur concentrations in the 2001 samples. St. Clair speculates that the source could be long range transport. Some of the SBW sites had a increase in cobalt, arsenic levels, and elevated Fe/Ti ratios between sampling periods. The Cu/Zn ratios were within background levels at all sites in 2000 to 2002. St. Clair concluded that the abundance of sensitive lichen indicator species and the high diversity of lichen species and well as substrate and growth form distribution patterns documents that the lichen flora in Selway Wilderness is healthy and relatively un-impacted by air pollution. These lichen findings are likely similar to lichen species and condition in the Gospel Hump Wilderness, particular the western Selway Bitterroot sites which are within 60 miles of the GHW with very few stationary sources of emissions in between. It should be noted, however, that the GHW is closer than the SBW to the point sources in Oregon and Washington, notably the Umatilla Weapons disposal and Hanford Nuclear Testing Facility. These sources along with has historical mineral exploration and would be expected to have slight potential lichen impacts. This WAQV plan will propose establish 2 lichen reference sites along Road 444 in the Moores Guard Station area.

Snow Chemistry

The United States Geological Survey (USGS) Water Resource Division in Colorado, in cooperation with the USFS, NPS, and multiple other agencies and interest groups has been monitoring 52 seasonal (late winter), depth integrated, bulk snowpack sites along the Continental Divide from New Mexico through Montana since 1993, (Ingersoll et. al., 2002, 2004, and 2005) http://pubs.usgs.gov/of/2001/ofr01-466/ . Two of these sites, Banner Summit (site #2 in map below) and Galena Summit (site #3 in map below) are on the Sawtooth National Forest about 131 miles and 192 miles south of the GHW respectively. Bulk late winter snowpack samples provide a very useful analysis of chemical deposition (H^+, Ca^{2+}, Mg^{2+}, Na^+, K^+, HN_4^+, SO_4+, NO_3-, and Cl-) from all transport sources (short and long range) through the late fall and winter period. The samples are collected in a depth integrated fashion prior to spring snowmelt rinsing of the snowpack which quickly flushes the soluble chemical constituents from the snowpacks (~~.~~ Ingersoll et. al., (2002). The snowpack monitoring has documented generally decreasing levels of snowpack contaminants from south (New Mexico and Colorado) north through Montana. The Banner Summit and Galena Summit sites have generally low (dilute) amounts of contaminants both in absolute values and relative to other Rocky Mountain sites as shown in the graphs below in Ingersoll et. al, 2003, for nitrate and sulfate http://pubs.usgs.gov/of/2005/1332/. The diameter of circle is representative of average nitrate and sulfate concentrations.





4) Wilderness Air Quality Values

Gospel Hump Wilderness

The key WAQVs for the Gospel Hump Wilderness are visibility/scenery and lake chemistry. These WAQV's are the most potentially sensitive parameters to atmospheric sources and are related to the GHW values which include flora, fauna, geologic features, odor, and cultural features.

Visibility/Scenery

The east-west hydrographic divide separates the GNW into a north portion draining into the South Fork of the Clearwater River, and a south portion draining into the Salmon River.

The southern boundary of the GHW joins the Frank Church River of No Return Wilderness (FCRONRW) at the Salmon River. In North America, the Salmon River canyon is exceeded in depth only by Hells Canyon on the Snake River. Elevations in the Wilderness range from 1970 feet at Wind River pack bridge on the Salmon River, to 8940 feet at the summit of Buffalo Hump. The GHW is part of approximately 3,000,000 acres of essentially roadless area in central Idaho. It contains rugged river break lands and high mountain lakes, offering opportunities for solitude, challenge, and primitive recreation. Scenery and visibility are important components of the wilderness values of the GHW. Visibility in the GHW is generally good due to absence of large stationary sources, generally dry air, and adequate wind dispersion. The SULA1, HECA1, and SAWT1 IMPROVE sites bracket the Gospel Hump Wilderness with only

very minor emission sources between these sites and the GHW. The HECA1 site, however, is at much lower elevation than the GHW and is only representative of regional, not local sources. The IMPROVE sites, however are reasonable~~y~~ approximations of visibility conditions in west central Idaho, including the HCW. Wildfire and occasional prescribed and agricultural burning are the main sources of periodic visibility impacts.

Lakes

The GHW has 86 lakes which area lakes are located in Eocene granite and Cretaceous granite watersheds of the Idaho Batholith. These lakes are an important component of the GHW wilderness setting and a key focus for wilderness recreation users. Lakes are generally considered sensitive to atmospheric induced acid deposition change if ANC is less than 50 ueq/L and highly sensitive if ANC is less than 25 ueq/L. A total of 8 lakes in the GHW have alkalinities of less than 50 ueq/L including Crescent, Upper Gospel, East Gospel, Lower Gospel, Upper Knob, West Knob, Oregon Butte, and Square Mountain and are sensitive lakes to acid deposition.

5) Gospel Hump Wilderness Air Quality Values Monitoring Plan

This plan is designed to specify appropriate monitoring to protect the Class 2 WAQVs in the Gospel Hump Wilderness and to meet the Wilderness Stewardship Challenge to achieve the objectives of the Air Element #3 http://www.wilderness.net/index.cfm?fuse=toolboxes&sec=air

The Wilderness Stewardship Challenge steps include selecting air quality values with an interdisciplinary team, rank air quality values, select receptors, and identify indicators to measure at the sensitive receptors. For the Gospel Hump Wilderness, the process included a review of existing air quality information in and adjacent to the GHW with a determination that existing monitoring in the IMPROVE, NADP, USGS snow chemistry, and USFS lichen monitoring networks is sufficient to characterize and monitor GHW air quality for the key sensitive receptor (scenic vistas) and sensitive indicator (visibility). The GHW monitoring plan proposes to add additional lake sampling in the most sensitive lakes. Additional NADP, visibility, or particulate monitoring is not proposed at this time since these air quality parameters are being reasonably adequately monitored in existing networks. In the future an additional IMPROVE or NADP site could be added to augment the existing network. Currently the IMPROVE and NADP programs are struggling to fund the existing networks and expansion in the foreseeable future, particularly to Class 2 areas, is unlikely. Air quality monitoring in the Gospel Hump Wilderness will continue to be done with the existing IMPROVE, NADP, USGS snow chemistry, and USFS lichen monitoring networks and tracked and tabulated by USFS R1 Air Resource Management staff. At the conclusion of the R1 Class 2 AQRV plan preparation, in 2008, the R1 AQ Program is planning to update the 7 Class 1 Wilderness AQRV plans summarize in a consolidated R1 Wilderness air quality assessment and monitoring plan. This GHW WAQV plan will need to be re-evaluated within a 5-10 year interval to insure monitoring sufficiency, particularly if the upper Flathead valley population continues to grow. Specific monitoring near the GHW includes:

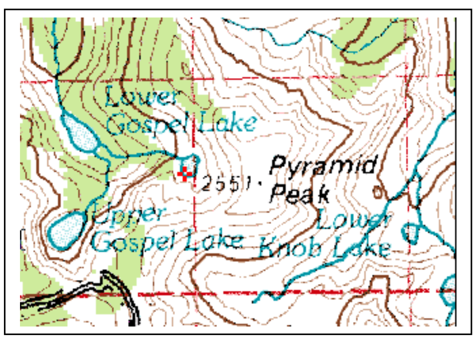
Visibility No additional visibility monitoring is needed to generally characterize this important WAQV in the Gospel Hump Wilderness. The Gospel Hump Wilderness is bracketed by 3 visibility monitoring IMPROVE sites with only very minor emission sources between these sites and the GHW. The IMPROVE sites include Hells Canyon (HECA1), Sula Peak (SULA1) for the Selway

Bitterroot Wilderness, and Sawtooth Wilderness (SAWT1). The Sula Peak Site is about 129 miles east of the GHW, Hells Canyon site about 60 miles west, and the Sawtooth Wilderness site about 135 miles south. The IMPROVE sites provide reasonable~~y~~ approximations of visibility conditions in the GHW although the HECA1 site is at much lower elevation than the GHW and is only representative of regional, not local sources. Visibility at these 3 IMPROVE sites has documented good visibility with periodic reduction during periods of active wildfire, particularly in 2003. No additional visibility monitoring stations are recommended or planned for the GHW. In the future an additional IMPROVE or NADP site could be added to augment the existing network, however currently the IMPROVE and NADP programs are struggling to fund the existing networks and expansion in the foreseeable future, particularly to Class 2 areas, is unlikely. A cursory visibility "baseline" in the GHW could be established with a $PM_{2.5}$ sampler and/or nephelometer at either the Square Mountain Viewpoint/Moores GS or Oregon Butte Lookout. Since line power is not available, the monitoring would need to be operated with battery and/or solar power which would complicate logistics and increase cost

Lakes The GHW lake information documents 8 lakes which are poorly buffered to pH change from atmospheric deposition (acid rain, acid snow and dry deposition). This WAQV plan includes monitoring of the EPA Western Lake Survey (1985) lake, West Kelly Lake 4C3-059 (listed as Kelly #4 in Bahls, 1990) plus the additional 8 lakes which Bahls (1990) reported with alkalinity of less than 50 ueq/L. Resampling West Kelly lake will allow of comparison of the cation/anion concentrations and balances with particular interest in nitrate concentration. The other lake data will allow a check of lake buffering capacity in 2007 compared to 1995. The lakes will be sampled in July 2007 to be consistent with the July sampling in all of the other USFS Region 1 lake sampling. Subsequent lake monitoring, if any, will depend on the 2007 lake monitoring results, interest and budgets of the Nez Perce Forest, and possible coordination with lake sampling of similar lakes in the Frank Church RONR Wilderness by the Salmon NF.

The lakes to be sampled in 2007 include:

Lake	Location
Crescent	26N 6E S13
Gospel, East	27N 4E S35
Gospel, Lower	27N 4E S35
Gospel, Upper	27N 4E S34
Kelly #4	27N 6E S26
Knob, Upper	27N 4E S1
Knob, West	26N 4E S2
Oregon Butte	25N 6E S12
Slate, Upper	26N 4E S15



Five of the lakes to be sampled include Gospel and Knob lakes shown in the above map.

Protocols for the lake sampling include collection of primary and duplicate samples in the deepest part of each lake (raft access) in 250 ml sample bottles using sterile techniques. Mark Story will provide the monitoring equipment, forms, and monitoring protocols. Surface Water Chemistry Monitoring Record Form and Chain of Custody forms will be completed and samples kept cool and immediately shipped to the USFS Fort Collins Science Center Lab. Laboratory analysis includes Fort Collins Science Center Lab Procedures**:** For pH & alkalinity--Acid Rain Analysis System (ARAS) gran technique; specific conductance--YSI meter; chloride, sulfate,

nitrate, ammonia, phosphate, calcium, potassium, sodium, magnesium --liquid ion chromatography; fluoride--ion specific electrode; aluminum and silica--Lachat flow injection system. Selected magnesium and calcium chromatography values with atomic absorption (Thermo Jarrell Ash 22E). All analyses used QA/QC guidelines and EPA reference standards established in the Handbook of Methods for Acid Deposition Studies (EPA 600/4-87/026 and Standard Methods (APHA, 1989). The data will be reviewed for conformance with quality assurance standards prior to use. All of the lake data will be available on the USFS NRIS-Air database and on spreadsheets by USFS R1 Air Quality staff. This Gospel Hump Wilderness WAQV plan will be updated in the fall of 2007 with data, conclusions, and monitoring recommendations based on the July 2007 sampling of the 10 lakes. The 2007 should be useful in deciding if continued lake monitoring beyond 2008 is reasonable. Additional criteria beyond ANC may be appropriate for selection of lake water sample locations such as basin area, lake volume, water retention time, geologic weathering potential, soils development and vegetation composition, recreation and mining activities, and presence or absence of fish. Eliminate lakes in the same drainage. Three lakes may be appropriate for future monitoring such Kelly #4, Upper Knob, and Upper Slate Lake. Parameters could be expanded to include zoo-plankton and phyto-plankton samples and possibly stream invertebrates to identify the more sensitive plant and animal species to atmospheric deposition.

Lichens

Lichen baseline sites will be established at 2 sites Road 444 in the Moores Guard Station area in conjunction with lichen re-sampling of the lichen sampling sites for the Selway Bitterroot Wilderness. The date of this sampling is not yet established. The sampling will consist of lichen amounts, lichen species and community composition, and elemental analysis of the lichen thallus tissue as described in St. Clair and Newberry (1994) and St. Clair, 2005. Documentation of the GHW lichen sampling will be included in the SBW report.

Snow Chemistry

Snow chemistry will continue to be cooperatively monitored in early March with the USGS Water Resource Division in Colorado. The 2 sites closest to the GHW include Banner Summit and Galena on the Sawtooth National Forest about 131 miles and 192 miles south of the GHW respectively. Bulk late winter snowpack samples provide a very useful metric of chemical deposition (H^+, Ca^{2+}, Mg^{2+}, Na^+, K^+, HN_4^+, SO_4+, NO_3-, and Cl-) from all transport sources (short and long range) through the late fall and winter period. The samples will be collected in a depth integrated fashion prior to spring snowmelt rinsing of the snowpack using techniques in (~~-~~Ingersoll et. al., (2002). The snow chemistry monitoring is funded with financial support from the USFS R1 Air Quality Program budget and logistical support from the ~~Salmon-Challis~~Sawtooth NF. Chemical analysis (H^+, Ca^{2+}, Mg^{2+}, Na^+, K^+, HN_4^+, SO_4+, NO_3-, and Cl-) will be analyzed in the USGS laboratory in Denver, Colorado ~~and~~ with data analysis and reporting completed by USGS Water Resource Division in Colorado. Snowpack chemistry data and reports are available at the USGS web site at http://co.water.usgs.gov/Pubs/index.html#OFR

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